REMARKS

The application has been amended and is believed to be in condition for allowance.

The previous pending claims have been amended and new claims added.

Claims 1-9, 12 and 13 stand rejected as obvious over JAIN et al. 6,417,092 in view of Applicant's Disclosed Prior Art ("APA").

Claims 10-11 stand rejected as obvious further in view of XU et al. 2003/0077916.

Claims 14-15 stand rejected as obvious further in view of LIU et al. 2004/0048468.

Claim 16 stands rejected as obvious further in view of NOGUCHI et al. 2002/0042193.

As to independent claim 1, the rejection rests on the prior art teaching of specification page 2, concerning Si-H bonds.

Claim 1 has been amended as to form and to clarify/add certain other features.

The recited embodiment comprises an interlayer dielectric film having Si-H bonds provided over a base layer; a silicon carbon nitride film formed over this interlayer dielectric film; an interconnection trench lined with a barrier metal nitride film, the barrier metal nitride film being non-occluding to hydrogen and contacting the interlayer dielectric

film having the Si-H bonds and the base layer; and an electrically conductive film filling an interior side of the interconnection trench, the conductive film forming a damascene interconnection.

Certain dependent claims have also been amended.

Claim 2 recites the electrically conductive film contains Cu as a main component element, and that the silicon carbon nitride film contacts the electrically conductive film.

Claim 14 has been amended to recite a metal film is provided between the Cu film containing and the metal nitride film, the metal nitride film having a nitrogen concentration of not less than 15 atm % but less than 40 atm %.

New claims are also added which are believed to patentably recite the present invention.

The prior art does not teach or suggest the recited combination of features.

The prior art teaches (from specification page 2) that, as a method of improving a signal propagation delay in interconnections, aluminum interconnections are replaced with copper interconnections. Furthermore, silicon oxide film has been studied to be replaced with a low-dielectric-constant interlayer dielectric film. Among films being studies is L-Ox (ladder oxide), a ladder-type hydrogenated polysiloxane, with Si-H bonds in part of the Si-O skeleton and is constituted from inorganic materials and, therefore, L-Ox has better adhesion to

interconnection metals than organic materials. However, the recited arrangement is not taught and the prior art is not known to be successful in the recited arrangement.

In a semiconductor device of the present invention (page 11, bottom), an interlayer dielectric film having Si-H bonds is provided over a base layer and a silicon carbon nitride film is formed over the interlayer dielectric film. The prior art is not believed to teach these features in combination with an interconnection trench lined with a barrier metal nitride film, ***the barrier metal nitride film being non-occluding to hydrogen*** and contacting the interlayer dielectric film having the Si-H bonds and the base layer, where an electrically conductive film fills an interior side of the interconnection trench to form a damascene interconnection.

Also note that, the suggestions of the prior art do not prove successful.

From the paragraph spanning specification pages 10-11, "[w]hen the present inventor used L-Ox as a low-dielectric-constant interlayer dielectric film and an SiC film as a barrier insulating film in the fabrication of a semiconductor device of the above-described damascene interconnection structure, a problem in electrical properties arose because the fabricating process required a long time."

"Furthermore, irrespective of the types of insulating film, the surface and interface of the Cu interconnection were

oxidized. In particular, there were problems of a rise in via resistance and an increase in the capacitance between interconnections. Furthermore, when a Ta single-layer film was used as a barrier metal film, peeling occurred at the interface between the L-Ox film and the Ta film during the CMP process for the formation of the first and second damascene interconnections and the via. Also, when the TaN single-layer film was used in place of the Ta film, the poor wettability of Cu by the TaN film posed the problem that Cu cannot be sufficiently embedded in the via of high aspect ratio etc."

Please refer to specification page 14, disclosing "the first step of forming an interlayer dielectric film having Si-H bonds on a semiconductor substrate; the second step of forming a trench in the interlayer dielectric film; the third step of forming a barrier metal film on a side wall and bottom surface of the trench; the fourth step of embedding an electrically conductive film containing Cu as a main component element in the trench in which the barrier metal film is formed; and the fifth step of forming a silicon carbon nitride film on the interlayer dielectric film and the electrically conductive film."

See the disclosure that "The third step involves forming a barrier metal film which is formed by sequentially laminating a metal nitride film and a metal film on a side wall and bottom surface of the trench. The electrically conductive film containing Cu as a main component element is an Si-

containing film in which a Cu film is subjected to silane treatment."

Also it is disclosed (spanning pages 16-17) that the cause of the peeling at the interface between an L-Ox film and a Ta film, which had occurred in the CMP fabrication process of conventional semiconductor devices, relates to occluding the hydrogen in the L-Ox film constituting conventional semiconductor devices into the Ta film. In recited embodiments of the present invention, a semiconductor device has such a configuration that an interlayer dielectric film having Si-H bonds is not in direct contact with a barrier metal layer having the function of occluding hydrogen, such as a Ta film. That is, a layer which suppresses the occlusion of the hydrogen in the interlayer dielectric layer into the barrier metal layer is interposed between the two layers (a metal nitride film has this suppressing effect and that a nitrogen concentration of a metal nitride film is not less than 15 atm % but less than 40 atm % is especially preferred).

See the new claims reciting an embodiment of the present invention with the barrier metal layer laminated by a metal film such as Ta having the function of occluding hydrogen and a film such as TaN or TiN being non-occluding of hydrogen. The metal film is disposed on the Cu interconnection side so as to form a Cu interconnection having a high aspect ratio, i.e., to ensure good embeddability in a trench provided in the interlayer

dielectric film, yet the non-occluding function is achieved by the metal nitride layer adjacent the dielectric film.

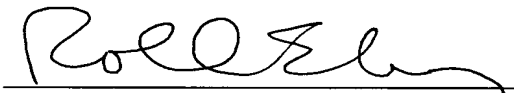
In that the prior art does not teach the recited features of the recited embodiments of the invention, the claims are believed to be non-obvious.

Applicant believes that the present application is in condition for allowance and an early indication of the same is respectfully requested.

The Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

YOUNG & THOMPSON



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